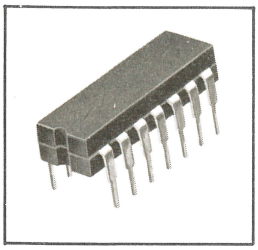
RCA-CA3047 is a high performance integrated circuit operational amplifier consisting of two differential amplifiers in cascade and a single-ended class-B power output stage on a single monolithic silicon chip. This device features high input impedance, high gain, high power output, and low input-offset voltage and current.

RCA-CA3047 is supplied in an easy-to-insert "dual-in-line" plastic package for applications requiring high packing densities.

OPERATIONAL AMPLIFIER

Two Differential Amplifiers in Cascade Plus One Single-Ended Class B Power Output Stage



JEDEC TO-116
PLASTIC PACKAGE

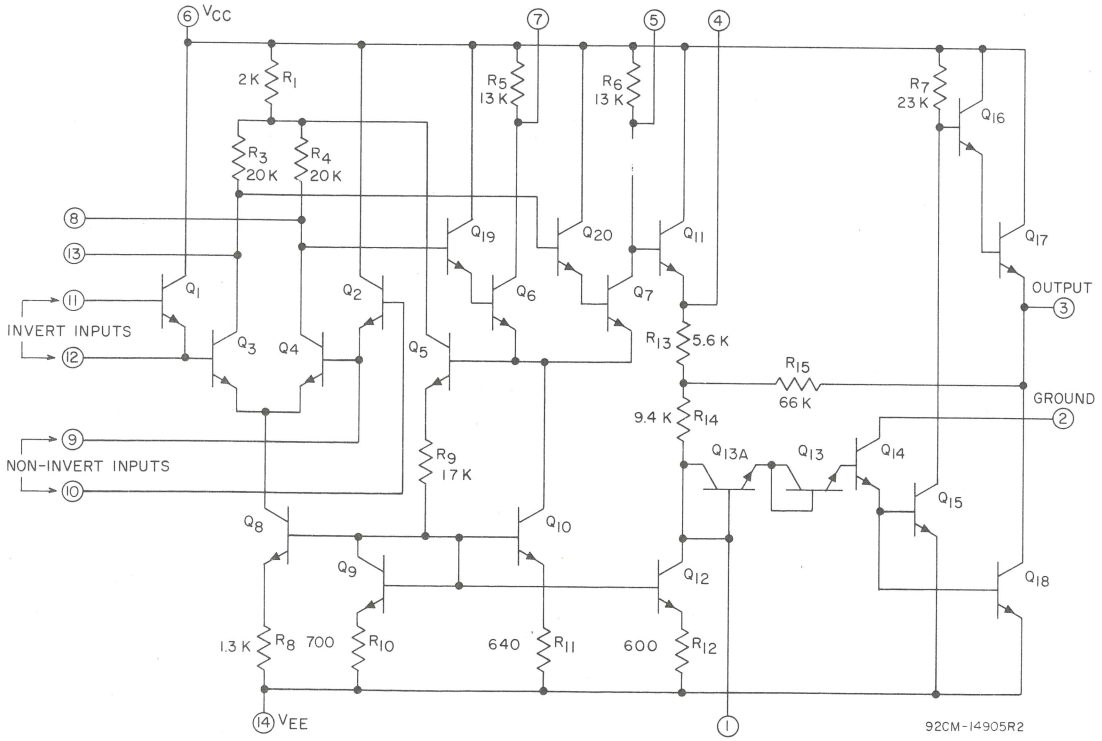
FEATURES

- High Open-Loop Differential Gain . . . . . 90 dB typ
- High Power Output Capability . . . . . 122 mW typ
- Large Output Voltage Swing . . . . . 22 Vp-p typ
- Very Low Input Offset Current . . . . . 5 nA typ
- Low Input Bias Current . . . . . 83 nA typ
- High Input Impedance . . . . . 1.5 MΩ typ
- Exceptionally High Common-Mode Rejection Ratio . . . . . 100 dB typ

APPLICATIONS

- Comparator
- Electrometer
- Audio Amplifier
- Power Amplifier
- Operational Functions
- Servo Driver
- DC & Video Amplifiers
- Multivibrator
- Oscillator
- Narrow Band and Band Pass Amplifiers
- Companion Application Note, ICAN-5641 "Application of RCA CA3033 and CA3033A High-Performance Integrated-Circuit Operational Amplifiers."

FIG.1 - SCHEMATIC DIAGRAM



The resistance values included on the schematic diagrams have been supplied as a convenience to assist Equipment Manufacturer's in optimizing the selection of "outboard" components of equipment designs. The values shown may vary as much as ± 30%.

RCA reserves the right to make any changes in the Resistance values provided such changes do not adversely affect the published performance characteristics of the device.

ABSOLUTE-MAXIMUM RATINGS

OPERATING AMBIENT TEMPERATURE RANGE . . . . . 0°C to +70°C
STORAGE AMBIENT TEMPERATURE RANGE . . . . . -25°C to +85°C
MAXIMUM INPUT-SIGNAL VOLTAGE● . . . . . ±10 V
MAXIMUM DEVICE DISSIPATION:▲
At Ambient Temperatures { up to 25°C. . . . . 750 mW
above 25°C . . . . . Derate at 6.67 mW/°C

Absolute-Maximum Voltage and Current Limits at T_A = 25°C

Voltage or current limits shown for each terminal can be applied under the indicated voltage or other circuit conditions for other terminals

All Voltages are with respect to ground (common terminal of Positive and Negative DC Supplies)

TERMINAL	VOLTAGE OR CURRENT LIMITS		CIRCUIT CONDITIONS*	
	NEGATIVE	POSITIVE	TERMINAL	VOLTAGE
1	12 V	50 mA	6 14 2 & 10	+12 -12 ground
2	12 V	14 V	6 14 10	+12 -12 ground
3	50 mA	50 mA	6 14 2 & 10	+12 -12 ground
4	20 mA	1 V	6 14 2 & 10	+12 -12 ground
5	0	12 V	6 14 2 & 10	+12 -12 ground
6	0	14 V	14 2 & 10	-12 ground
7	0	12 V	6 14 2 & 10	+12 -12 ground
8	0	12 V	6 14 2 & 10	+12 -12 ground

TERMINAL	VOLTAGE OR CURRENT LIMITS		CIRCUIT CONDITIONS*	
	NEGATIVE	POSITIVE	TERMINAL	VOLTAGE
9	10 V	10 V 10 mA	6 14 2 & 10	+12 -12 ground
10	10 V	10 V 10 mA	6 14 2	+12 -12 ground
11	10 V	10 V 10 mA	6 14 2 & 10	+12 -12 ground
12	10 V	10 V 10 mA	6 14 2 & 10	+12 -12 ground
13	0	12 V	6 14 2 & 10	+12 -12 ground
14	14 V	0	6 2 & 10	+12 ground
CASE	INTERNALLY CONNECTED TO TERMINAL No.14 DO NOT GROUND			

● Under no circumstances should current exceed 10 mA. See voltage and current limits for Terminals 9 through 12.

▲ Maximum dissipation capability of 14-lead plastic dual in-line package.

* 1 MΩ between terminals No.11 and 3, 1 μF from terminal No.13 to ground and 1 μF from terminal No.13 to ground and 1 μF from terminal No.8 to ground.

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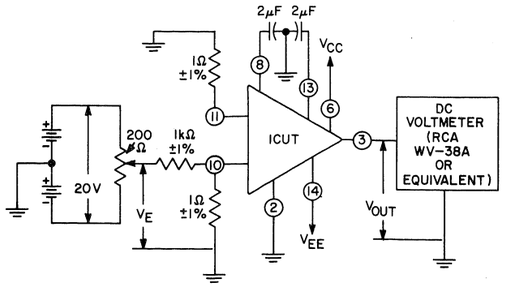
ELECTRICAL CHARACTERISTICS AT T_A = 25°C, V_{CC} = +12V, V_{EE} = -12V

Characteristics	Symbols	Test Circuits	Special Test Conditions	Limits CA3047			Units	Typical Characteristics Curves
		Fig.		Min.	Typ.	Max.		Fig.
STATIC CHARACTERISTICS								
Input Offset Voltage	V_{IO}	2		-	2.6	5	mV	2A
Input Offset Current	I_{IO}	3		-	5	35	nA	3A
Input Bias Current	I_I	3		-	83	350	nA	3B
Input Offset Voltage Drift -55°C to 125°C	$V_{IO}/\Delta T$	2		-	6.6	-	μV/°C	2A
Input Offset Current Drift -55°C to 25°C	$I_{IO}/\Delta T$	3		-	1	-	nA/°C	3A
25°C to 125°C				-	.08	-	nA/°C	
Input Offset Voltage Sensitivity: Positive	$\Delta V_{IO}/\Delta V_{CC}$	2		-	0.3	0.5	mV/V	none
Negative	$\Delta V_{IO}/\Delta V_{EE}$	2		-	0.3	0.5	mV/V	none
Device Dissipation	P_T	2		60	120	180	mW	none
DYNAMIC CHARACTERISTICS: f = 1 kHz for all but BW								
Open-Loop Differential Voltage Gain	A_{OL}	4		84	90	-	dB	4A 4B
60 dB-Amplifier Bandwidth at -3 dB Point	BW	4C	C_x, C_y = 0.001 μF	-	230	-	kHz	4B
Common-Mode Rejection Ratio	CMR	5		84	100	-	dB	5A
Common-Mode Input-Voltage Range	V_{CMR}	5		-7.5	+5,-9	+3.5	V	none
Maximum Output-Voltage Swing	V_O(P-P)	4	R_L = 500 Ω	18	22	-	V_{P-P}	none
Input Impedance	Z_{in}	6		0.15	1.5	-	MΩ	none
Output Current	I_o	4	R_L = 500 Ω	36	44	-	mA(P-P)	4D
Slew Rate	SR	none		-	1.2	-	V/μs	none
Power Output (THD 10%)	P_o	4	R_L = 500 Ω C_x, C_y = 0.001 μF	80	122	-	mW	4E

FIG.2 - INPUT OFFSET VOLTAGE, INPUT OFFSET VOLTAGE SENSITIVITY, AND DEVICE DISSIPATION TEST CIRCUIT



Procedure: 92CS-14895

INPUT OFFSET VOLTAGE

1. Adjust V_E for a DC Output Voltage (V_{OUT}) of 0 ± 0.1 volts.
2. Measure V_E and record Input Offset Voltage in millivolts as $V_E/1000$.

INPUT OFFSET VOLTAGE SENSITIVITY

1. Adjust V_E for a DC Output Voltage (V_{OUT}) of 0 ± 0.1 volts.
2. Increase V_{CC} by 1 volt and record output voltage (V_{OUT}).
3. Decrease V_{CC} by 1 volt and record output voltage (V_{OUT}).
4. Divide the difference between V_{OUT} measured in steps 2 and 3 by change in V_{CC} in steps 2 and 3

$$\frac{V_{OUT}}{V_{CC}} = \frac{V_{OUT}(\text{step 2}) - V_{OUT}(\text{step 3})}{2 \text{ volts}}$$

5. Refer the reading to the input by dividing by the Open Loop Voltage Gain (A_{OL}).

$$V_{IO}/V_{CC} = \frac{V_{OUT}/V_{CC}}{A_{OL}}$$

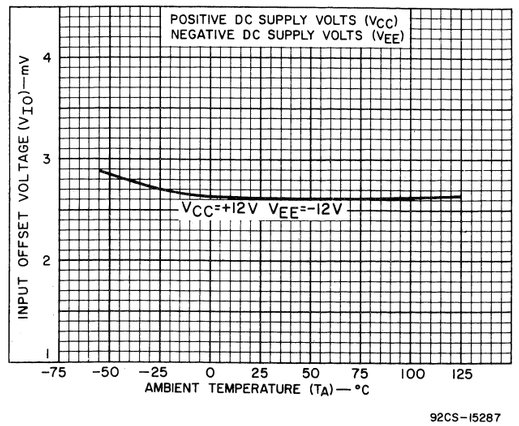
6. Repeat procedures 1 through 5 for the Negative Supply (V_{EE}).
7. Device Dissipation

$P_T = V_{CC}I_C + V_{EE}I_E$

I_C = Direct Current into Terminal No.6.

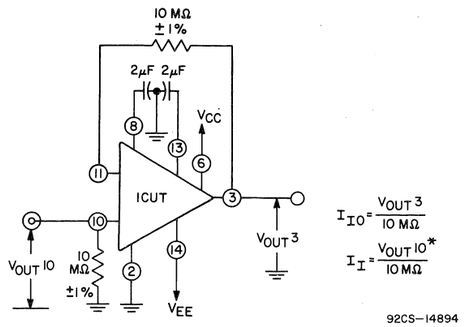
I_E = Direct Current out of Terminal No.14.

FIG.2A - TYPICAL INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE


POSITIVE DC SUPPLY VOLTS (VCC)
NEGATIVE DC SUPPLY VOLTS (VEE)
INPUT OFFSET VOLTAGE (VIO)—mV
VCC=+12V VEE=-12V
AMBIENT TEMPERATURE (TA) — °C

92CS-15287

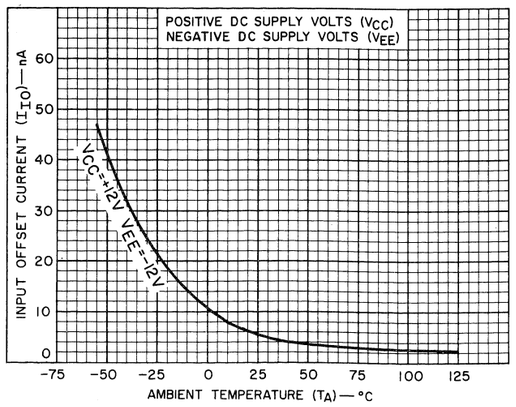
FIG.3 - INPUT OFFSET CURRENT AND INPUT BIAS CURRENT TEST CIRCUIT



92CS-14894

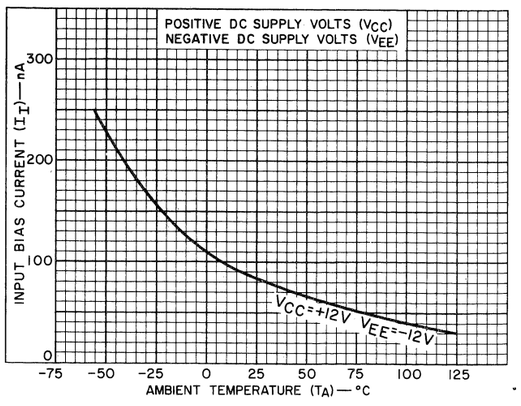
* This measurement must be made with a differential voltmeter that provides extremely high input resistance at null.

FIG.3A - TYPICAL INPUT OFFSET CURRENT VS. AMBIENT TEMPERATURE


POSITIVE DC SUPPLY VOLTS (VCC)
NEGATIVE DC SUPPLY VOLTS (VEE)
INPUT OFFSET CURRENT (IIO)—nA
VCC=+12V VEE=-12V
AMBIENT TEMPERATURE (TA) — °C

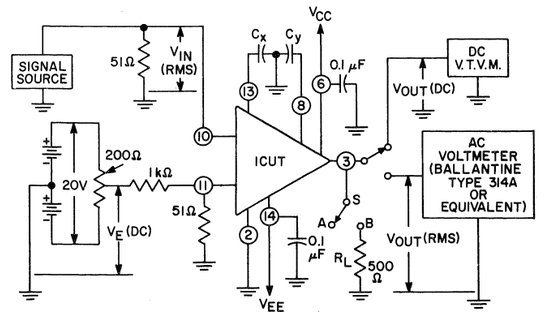
92CS-15288

FIG.3B - TYPICAL INPUT BIAS CURRENT VS. AMBIENT TEMPERATURE


POSITIVE DC SUPPLY VOLTS (VCC)
NEGATIVE DC SUPPLY VOLTS (VEE)
INPUT BIAS CURRENT (II)—nA
VCC=+12V VEE=-12V
AMBIENT TEMPERATURE (TA) — °C

92CS-15289

FIG.4 - OPEN-LOOP DIFFERENTIAL VOLTAGE GAIN MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE, OUTPUT CURRENT AND POWER OUTPUT



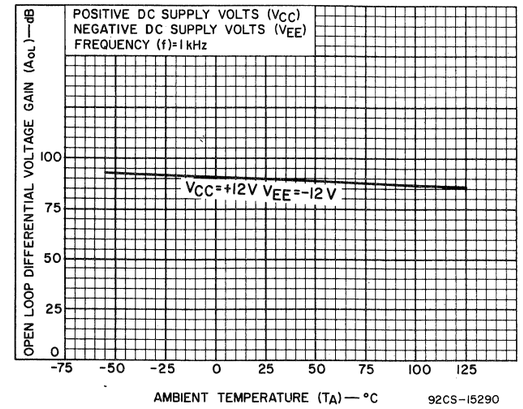
92CS-14896RI

1. Adjust V_E for V_{OUT} = 0 ± 0.1 V DC.
2. Set Switch "S" to Position A.
3. Measure Open-Loop Differential Voltage Gain (A_{OL}) at f = 1 kHz.

$$A_{OL} = 20 \text{ Log}_{10} \frac{V_{OUT}}{V_{IN}}$$

4. Measure Maximum Peak-to-Peak Output Voltage at f = 1 kHz.
5. Set Switch "S" to Position B.
6. Measure Output Voltage.

FIG.4A - TYPICAL OPEN-LOOP DIFFERENTIAL VOLTAGE GAIN VS. AMBIENT TEMPERATURE


POSITIVE DC SUPPLY VOLTS (VCC)
NEGATIVE DC SUPPLY VOLTS (VEE)
FREQUENCY (f)=1 kHz
OPEN LOOP DIFFERENTIAL VOLTAGE GAIN (AOL)—dB
VCC=+12V VEE=-12V
AMBIENT TEMPERATURE (TA) — °C

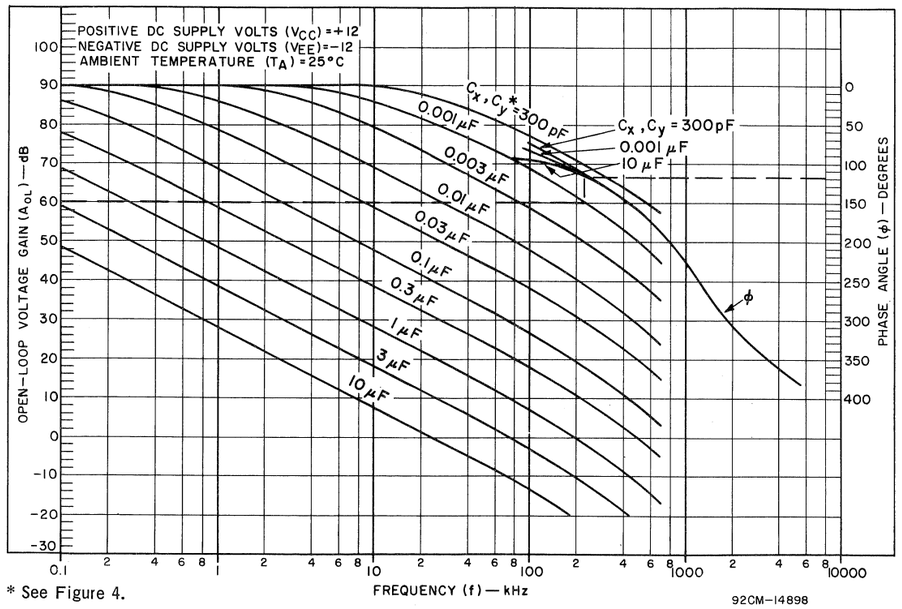
92CS-15290

7. Calculate Output Current and Power Output

$$I_o = \frac{V_{o\,p\text{-}p}}{500}$$

$$P_{out} = \frac{V_o^2(\text{rms})}{500}$$

FIG.4B - TYPICAL PHASE COMPENSATION CHARACTERISTICS (V_{CC} = +12V, V_{EE} = -12V)



* See Figure 4.

92CM-14898

For any desired closed loop gain (in decibels), read horizontally along the gain line to the attenuation curve which provides the desired closed loop bandwidth. The required values for the compensation capacitors is shown on the curve. Move vertically from the intersection of the gain and attenuation lines until the phase angle curve (ϕ) is reached and read the phase angle between the input and output on the right-hand scale. The difference between the indicated phase angle and 180° is the typical phase margin. (A minimum phase margin of 45° is recommended to allow for component variations and differences among amplifiers.) If the phase margin is smaller than required, the desired bandwidth can be stably achieved through the use of a more complex feedback network.

Figure 4C shows the phase compensating capacitors (C_x, C_y) returned to ground. In some systems with large parasitic impedances in the power supply system, returning these capacitors to the negative (V_{EE}) supply may result in more stable operation.

FIG.4C - TYPICAL 60 dB AMPLIFIER

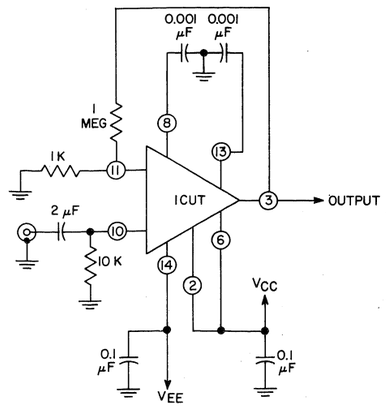


FIG.4D - TYPICAL PEAK-TO-PEAK OUTPUT CURRENT VS. LOAD RESISTANCE

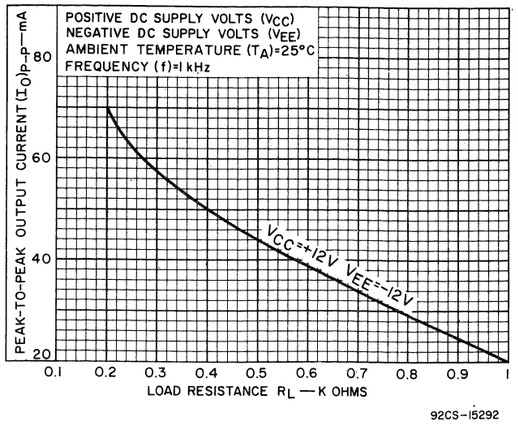


FIG.4E - TYPICAL POWER VS. LOAD RESISTANCE

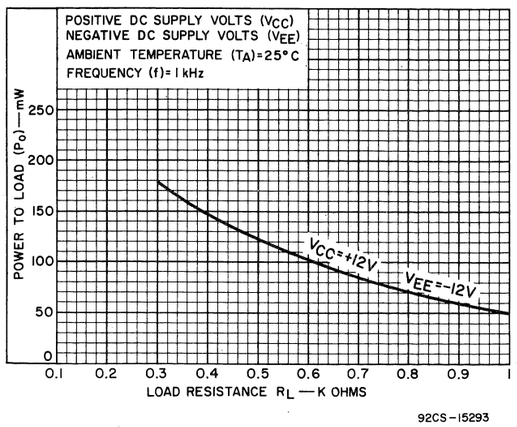
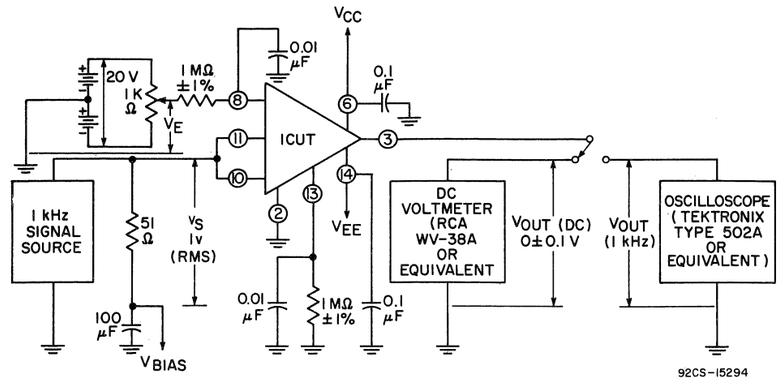


FIG.5 - COMMON MODE REJECTION TEST CIRCUIT



Procedure:

COMMON-MODE REJECTION RATIO:

1. Set V_{BIAS} = 0. Adjust V_E for V_{OUT}(DC) = 0 ± 0.1 V.
2. Apply 1-kHz sinusoidal input signal and adjust for V_S = 1.0 V (RMS).
3. Measure and record the RMS value of V_{OUT}. An oscilloscope is used for this measurement so that the output signal may be visually separated from noise output.
4. Calculate Common-Mode Voltage Gain:

   $A_{CM} = V_{OUT}/V_S$

   A_{CM} in dB = -20 LOG_{10} V_S/V_{OUT}
5. Calculate Common-Mode Rejection Ratio:

   CMR in dB = A_{DIFF} in dB - A_{CM} in dB.

COMMON-MODE INPUT-VOLTAGE RANGE:

1. Calculate and record CMR for various positive and negative values of V_{BIAS} within the maximum limits shown on Page 2. The Common-Mode Input-Voltage Range limits are those values of V_{BIAS} at which CMR is 6 dB less than that calculated in Step 5 of the procedure given above.

FIG.5A - TYPICAL COMMON MODE REJECTION VS. AMBIENT TEMPERATURE

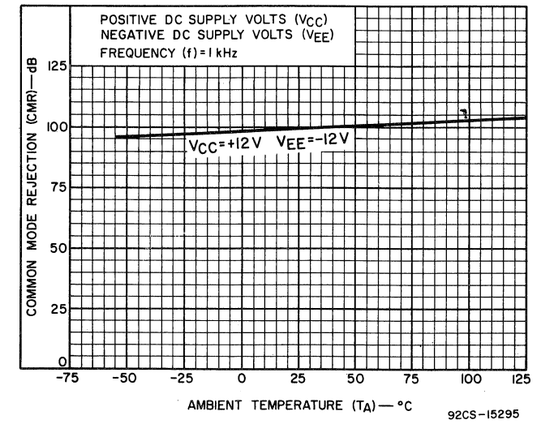
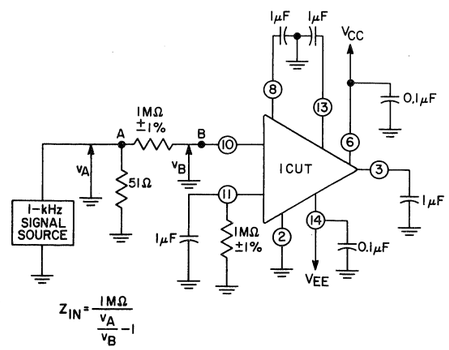
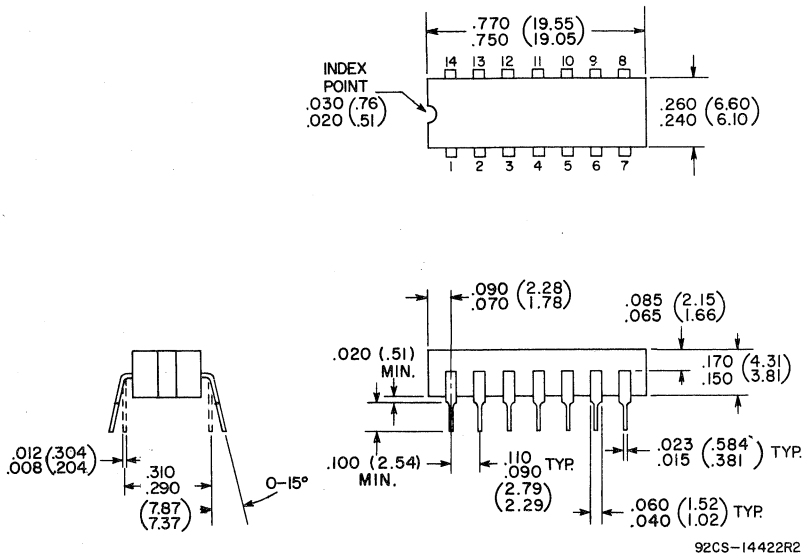


FIG.6 - SINGLE-ENDED INPUT IMPEDANCE TEST CIRCUIT



DIMENSIONAL OUTLINE

JEDEC TO-116



DIMENSIONS IN INCHES AND MILLIMETERS

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.